

WHAT IS CLAIMED IS:

1. A method of measuring the force applied to a body, comprising:
transmitting a cyclically-repeating acoustical wave through a transmission channel in said body from a first location thereon to a second location thereon;
measuring the transit time of said acoustical wave through said transmission channel from said first location to said second location;
and utilizing said measured transit time to produce a measurement of said force.
2. The method according to Claim 1, wherein said body is a connecting body connecting a first member to a second member.
3. The method according to Claim 2, wherein said connecting body is a fastening plate which fastens said first member to said second member, and which is strained by said force applied to said fastening plate such that the measured transit time of the cyclically-repeating acoustical wave through said transmission channel represents a measurement of said strain, and thereby a measurement of the force applied to said fastening plate.
4. The method according to Claim 3, wherein said first and second members are first and second rotary members fastened for rotation together about a common axis of rotation by said fastening plate, such that the force measured is the torque applied by said first rotary member to said second rotary member.
5. The method according to Claim 4, wherein said fastening plate is fixed at a first fixation point to said first rotary member, and at a second fixation point to said second rotary member; said transmission channel of the fastening plate being between said first and second fixation points such that said measured transit time of the cyclically-repeating energy wave represents a measurement of the strain of the fastening plate in said transmission channel between said first and second fixation points.

6. The method according to Claim 5, wherein said second fixation point is spaced from said first fixation point along a tangential line substantially perpendicular to a radial line from said first fixation point to said axis of rotation, such that the section of the fastening plate between said first and second fixation points is deformed by being expanded or contracted, depending on the direction of rotation of said rotary members.

7. The method according to Claim 6, wherein said fastening plate is also fixed to said second rotary member at a third fixation point, said third fixation point being on said tangential line but on the opposite side of said first fixation point as said second fixation point, and being equally spaced from said first fixation point as said second fixation point, such as to produce, between said first and third fixation points, another transmission channel in the fastening plate which is deformed in the opposite sense as said first-mentioned transmission channel during the rotation of said drive shaft; said latter deformation also being measured and utilized to produce a measurement of said torque.

8. The method according to Claim 7, wherein said fastening plate is formed with a slot formation defining said first and second transmission channels in the fastening plate undergoing deformation during the rotation of the drive shaft.

9. The method according to Claim 5, wherein said fastening plate is of metal and is fixed to said first and second rotary members by metal fasteners received in sockets floatingly mounted to said fastening plate by slots filled with insulating material to minimize reflections in the acoustical waves.

10. The method according to Claim 5, wherein the two rotary members are coupled together by a plurality of said fastening plates equally spaced eccentrically around the axis of rotation of the rotary members.

11. The method according to Claim 5, wherein said first rotary member is a drive shaft of a vehicle, and said second rotary member is a driven shaft of the vehicle.

12. The method according to Claim 1, wherein the transit time of said cyclically-repeating acoustical wave from said first location to said second location is measured by:

detecting a predetermined fiducial point in the cyclically-repeating acoustical wave received at said second location;

continuously changing the frequency of transmission of the cyclically-repeating acoustical wave in accordance with the detected fiducial point of each received wave such that the number of waves received is a whole integer;

and utilizing the measured change in frequency to produce a measurement of said transit time of the cyclically-repeating acoustical wave from said first location to said second location.

13. A method of measuring the torque applied by a drive shaft to a driven shaft along a common axis of rotation, comprising:

coupling said shafts together by fixing at least one torque sensor plate to one of said shafts at a first fixation point eccentric with respect to said common axis of rotation, and to the other one of said shafts at a second fixation point spaced from said first fixation point;

measuring the deformation of said torque sensor plate in a section thereof between said first and second fixation points;

and utilizing said measured deformation to produce a measurement of said torque;

said second fixation point being spaced from said first fixation point along a tangential line substantially perpendicular to a radial line from said first fixation point to said axis of rotation, such that the deformed section of the torque sensor plate between said first and second fixation points is expanded or contracted, depending on the direction of rotation of said drive shaft.

14. The method according to Claim 13, wherein said torque sensor plate is also fixed to said other one of said shafts at a third fixation point, said third fixation point being on said tangential line but on the opposite side of said first fixation point as said second fixation point, and being equally spaced from said first fixation point as said second fixation point such as to produce, between said first and third fixation points, another section of the torque sensor plate which is deformed in the opposite sense as said first-mentioned section during the rotation of said drive shaft; said latter deformation also being measured and utilized to produce a measurement of said torque.

15. The method according to Claim 13, wherein the two shafts are coupled together by a plurality of said torque sensor plates equally spaced eccentrically around the axis of rotation of the shafts.

16. The method according to Claim 13, wherein the deformation of said torque sensor plate in the section between said first and second fixation points is measured by:

transmitting a cyclically-repeating energy wave from one side of said section towards the other side of said section;

receiving the cyclically-repeating energy wave at the other side of said section;

detecting a predetermined fiducial point in the received cyclically-repeating energy wave;

continuously changing the frequency of transmission of the cyclically-repeating energy wave in accordance with the detected fiducial point of each received wave such that the number of waves received is a whole integer;

measuring the change in frequency; and

utilizing the measured change in frequency to produce a measurement of the deformation of the torque sensor plate in said section between said first and second fixation point, and thereby a measurement of said torque.

17. The method according to Claim 16, wherein said torque sensor plate is of metal and is fixed to said first and second rotary members by metal fasteners received in

sockets floatingly mounted to said torque sensor plate filled with insulating material to minimize reflections in the acoustical waves.

18. The method according to Claim 13, wherein said drive shaft is the output shaft of a vehicle engine.

19. Apparatus for measuring the force applied to a body, comprising:
a transmitter at a first location on said body for transmitting a cyclically-repeating acoustical wave through a transmission channel in said body to a second location thereon;
a receiver at said second location on said body for receiving said cyclically-repeating acoustical wave;
and an electrical system for measuring the transit time of the cyclically-repeating acoustical wave through said transmission channel from said first location to said second location and for utilizing said measured transit time to produce a measurement of said force.

20. The apparatus according to Claim 19, wherein said body is a connecting body connecting a first member to a second member.

21. The apparatus according to Claim 20, wherein said connecting body is a fastening plate which fastens said first member to said second member, and which is strained by said force applied to said fastening plate such that the measured transit time of the cyclically-repeating acoustical wave through said transmission channel represents a measurement of said strain, and thereby a measurement of the force applied to said fastening plate.

22. The apparatus according to Claim 21, wherein said first and second members are first and second rotary members fastened for rotation together about a common axis of

rotation by said fastening plate, such that the force measured is the torque applied by said first rotary member to said second rotary member.

23. The apparatus according to Claim 22, wherein said fastening plate is fixed at a first fixation point to said first rotary member, and at a second fixation point to said second rotary member; said transmission channel of the fastening plate being between said first and second fixation points such that said measured transit time of the cyclically-repeating energy wave represents a measurement of the strain of the fastening plate in said transmission channel between said first and second fixation points.

24. The apparatus according to Claim 23, wherein said second fixation point is spaced from said first fixation point along a tangential line substantially perpendicular to a radial line from said first fixation point to said axis of rotation, such that the deformed section of the fastening plate between said first and second fixation points is expanded or contracted, depending on the direction of rotation of said rotary members.

25. The apparatus according to Claim 24, wherein said fastening plate is also fixed to said second rotary member at a third fixation point, said third fixation point being on said tangential line but on the opposite side of said first fixation point as said second fixation point, and being equally spaced from said first fixation point as said second fixation point, such as to produce, between said first and third fixation points, another transmission channel in the fastening plate which is deformed in the opposite sense as said first-mentioned transmission channel during the rotation of said drive shaft; said latter deformation also being measured and utilized to produce a measurement of said torque.

26. The apparatus according to Claim 25, wherein said fastening plate is formed with a slot formation defining said first and second transmission channels in the fastening plate undergoing deformation during the rotation of the drive shaft.

27. The apparatus according to Claim 23, wherein said fastening plate is of metal and is fixed to said first and second rotary members by metal fasteners received in sockets floatingly mounted to said fastening plate by slots filled with insulating material to minimize reflections in the acoustical waves.

28. The apparatus according to Claim 23, wherein the two rotary members are coupled together by a plurality of said rotary member fastening plates equally spaced eccentrically around the axis of rotation of the rotary members.

29. The apparatus according to Claim 23, wherein said first rotary member is a drive shaft of a vehicle, and said second rotary member is a driven shaft of the vehicle.

30. The apparatus according to Claim 19, wherein said electrical system measures said transit time by:

detecting a predetermined fiducial point in the cyclically-repeating acoustical wave received at said second location;

continuously changing the frequency of transmission of the cyclically-repeating acoustical wave in accordance with the detected fiducial point of each received wave such that the number of waves received is a whole integer;

and utilizing the measured change in frequency to produce a measurement of said transit time of the cyclically-repeating acoustical wave from said first location to said second location.